Space Weather Technical Forecast

Issued on Tuesday 14 January 2025 at 12:31 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Slight Chance of isolated M-class flares, slowly increasing. HSS enhancement likely.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low during the last 24 hours with only C-class flares recorded.

There are seven sunspot regions on the visible disc. AR3947 has historically been the most magnetically complex group, but analysis is now difficult as it rotates over the western limb. AR3959 continues to move further into view in the northeast, with small spots becoming visible surrounding the large forward spot. A new region is rotating around the southeast limb, with its classification likely to change as it moves further into view. Other regions remain smaller and simple with limited overall change.

No Earth-bound CME's were observed during this period.

Solar Wind / Geomagnetic Activity: Solar winds observed at L1 by ACE/DSCOVR were at slightly elevated levels with the likely onset of the HSS of CH08/-, ranging between 400-500 km/s. The density of the solar wind was mainly average to below average. The Interplanetary Magnetic Field, Bt, was at weak levels, between 5-8nT. The north-south component, Bz, varied weakly between -6nT and +6nT. The Phi angle was negative (towards the Sun). Geomagnetic activity was Quiet (Kp1-2).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES-18 was at background levels. High energy electron flux (greater than 2MeV) at GOES16 was at background to moderate levels. The associated 24 hour fluence remained below the Active threshold, reading 2.65e6 integrated pfu at 14/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Low, with a slowly increasing chance of isolated M-class flares and a very slight chance of isolated X-class flares, mainly due to AR3947 in the northwest disc or any spots that rotate over the eastern limb later in the period.

Solar Wind / Geomagnetic Activity: Solar winds are currently slightly elevated, with observed speeds now around 420-450 km/s. The expected source is thought to be a HSS enhancement

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associated with CH08/- in the west of the disc. Speeds most likely remaining at slightly elevated to elevated levels through Day 1 (14 Jan), before easing Days 2 (15 Jan). A connection to CH09/- is then possible from late on Day 3 (16 Jan) or early on Day 4 (17 Jan)., with solar winds likely increasing once again. No CMEs currently feature in the forecast.

Geomagnetic activity is expected to be mainly Quiet to Unsettled (Kp1-3) throughout, but with a chance of Active (Kp4) intervals in association with coronal hole HSS enhancements. There is a slight chance of isolated G1 Minor Geomagnetic Storms (Kp5) Days 3-4 (16-17 Jan) in association with CH09/-.

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is expected to remain at background levels, with only a slight chance of rising in response to any notable flares. GOES-16 high-energy electron flux is anticipated to remain at background levels due to ongoing and future HSS influences. Electron fluence is expected to remain below the active threshold throughout.

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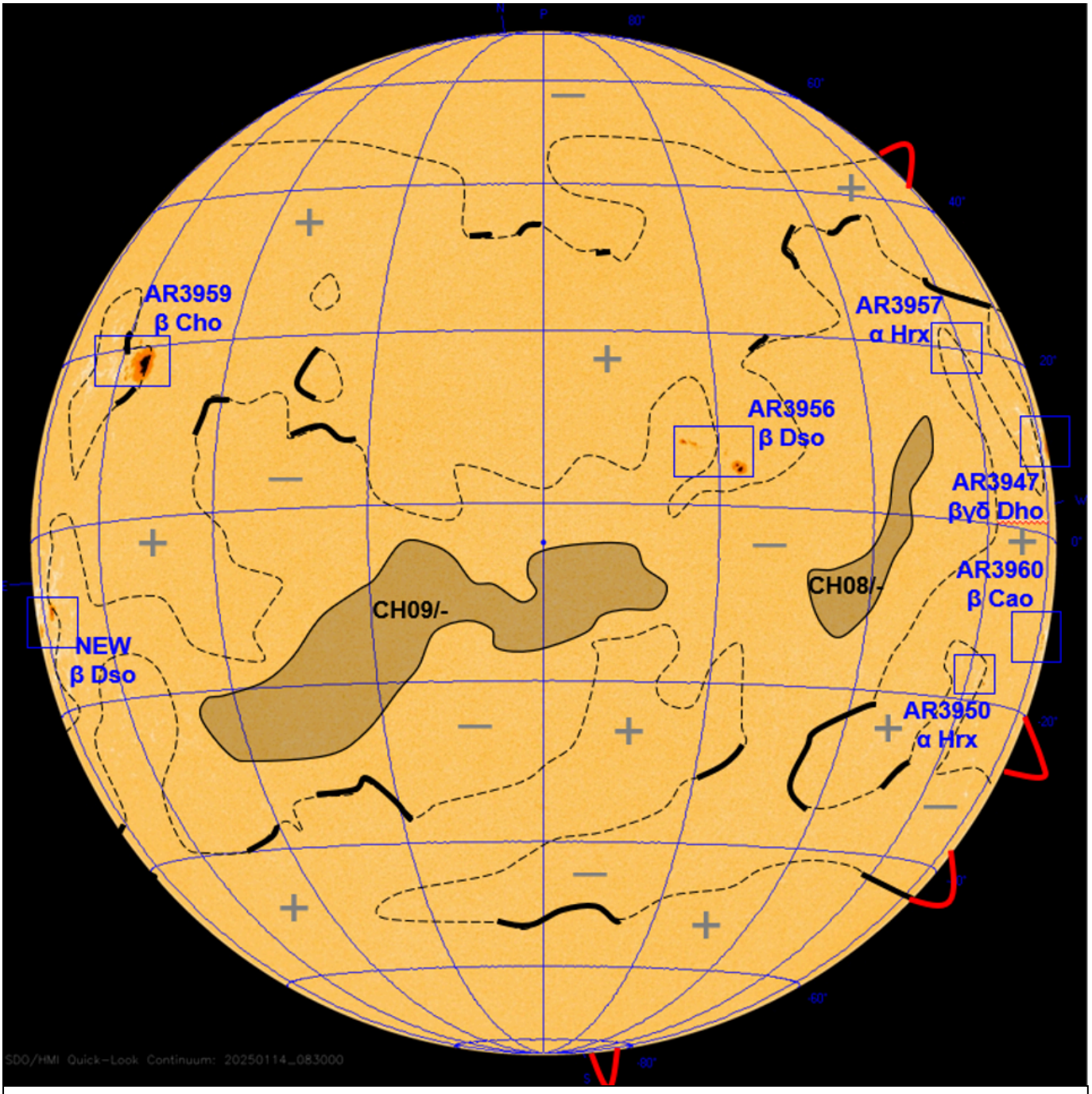
Figure 1: Solar Synoptic Map valid 14/0830 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

Solar winds are slightly elevated, with observed speeds now around 420-450 km/s. The expected source is thought to be a HSS enhancement associated with CH08/- in the west of the disc. Speeds most likely remaining at slightly elevated to elevated levels through Day 1 (14 Jan). This evolution notably different than indicated by MOSWOC's ENLIL model, which appears to overestimate both the onset time and longevity of CH08/-, as well as the associated HSS speed, with solar wind speeds expected to gradually decrease perhaps back to background on Day 2 (15 Jan). This may prove brief however with a connection to CH09/-, a larger and darker coronal hole currently nearing the central disc in the southern hemisphere, is likely to lead to another enhancement in solar wind speeds late on Day 3 (16 Jan) or early on Day 4 (17 Jan).

There is the possibility for solar winds to remain slightly enhanced throughout the forecast period, as CH08/- and CH09/- were initially one large and elongated coronal hole. Whilst imagery would suggest they have split into two discrete coronal holes over the past few days, flux lines in imagery may be obscuring a connection between these two regions, hence the possibility for the ongoing enhancement to continue longer than currently thought. This is low confidence however.

No CMEs currently feature in the forecast.

Geomagnetic activity is expected to be mainly Quiet to Unsettled (Kp1-3) throughout, but with a chance of Active (Kp4) intervals in association with coronal hole HSS enhancements. There is a slight chance of isolated G1 Minor Geomagnetic Storms (Kp5) Days 3-4 (16-17 Jan) in association with CH09/-.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	1	15	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Radio Blackouts - X-Ray Flares

Solar activity has been Low during the last 24 hours with only C-class flares recorded.

There are seven sunspot regions on the visible disc. AR3947 has historically been the most magnetically complex group, but analysis is now difficult as it rotates over the western limb. AR3959 continues to move further into view in the northeast, with small spots becoming visible surrounding the large forward spot. A new region is rotating around the southeast limb, with its classification likely to change as it moves further into view. Other regions remain smaller and simple with limited overall change.

Evidence of magnetic looping in SDO 171 imagery near the eastern limb suggests the potential for new regions to rotate onto the facing-disc in the coming days. Helio-seismic data is supportive of this and corresponds to expected locations for Ex-AR3933 and Ex-AR3936, with the New region currently rotating over the eastern limb likely corresponding to one of these regions.

Overall, a slight chance of isolated M-class flares initially, this risk steadily increasing to a chance through the period as further regions are expected to rotate on. The risk of isolated X-class flares very slight but also increasing.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 (M Class)**	No	25	30	35	40
Very Active	**R3-R5 (X Class)**	No	5	5	10	10

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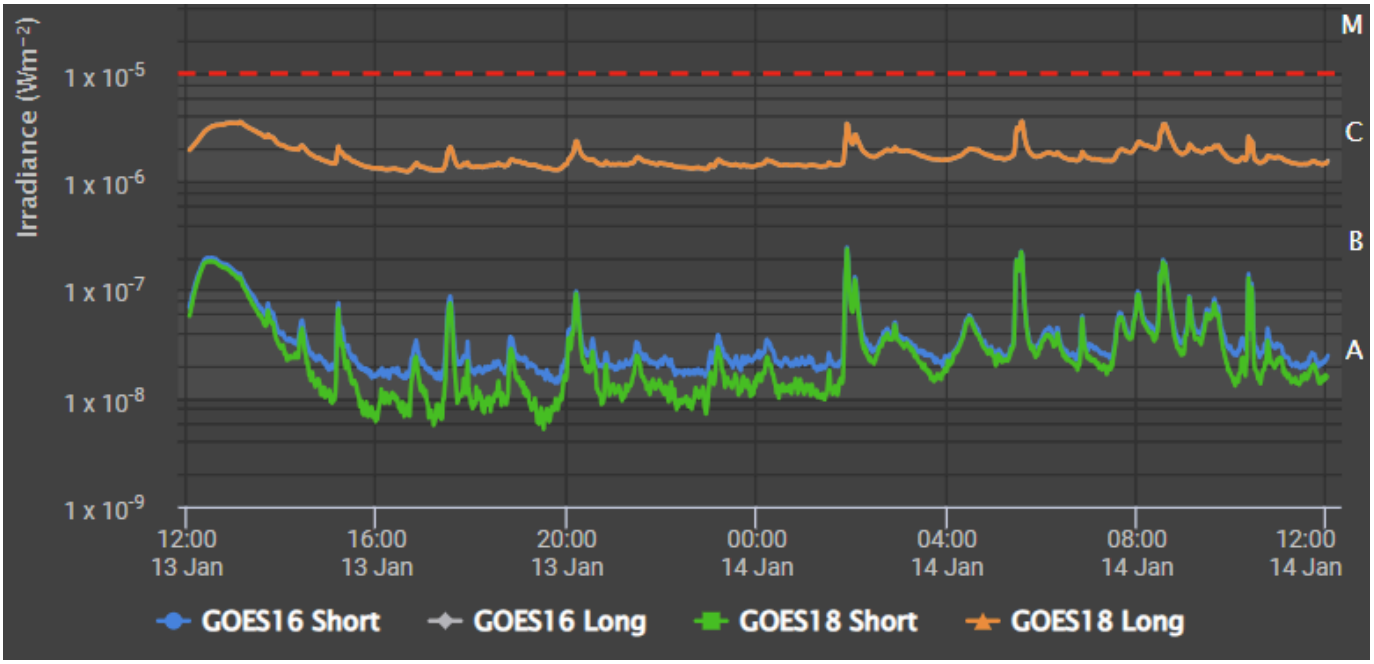
Figure 2: GOES-16 & -18 X-ray flux.



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Solar Radiation Storms (High Energy Protons)

GOES18 high energy proton flux has remained at background over the last 24 hours. There is a slight chance of an enhancement as AR3947, the most complex spot, continues to transit the western hemisphere during the forecast period, rotating off of the visible disc during Day 1 (14 Jan) but will still present a risk of enhancement though the period. This region was previously the source of multiple M-class flares and isolated X-class flares, but with a reduction in significant flares recently.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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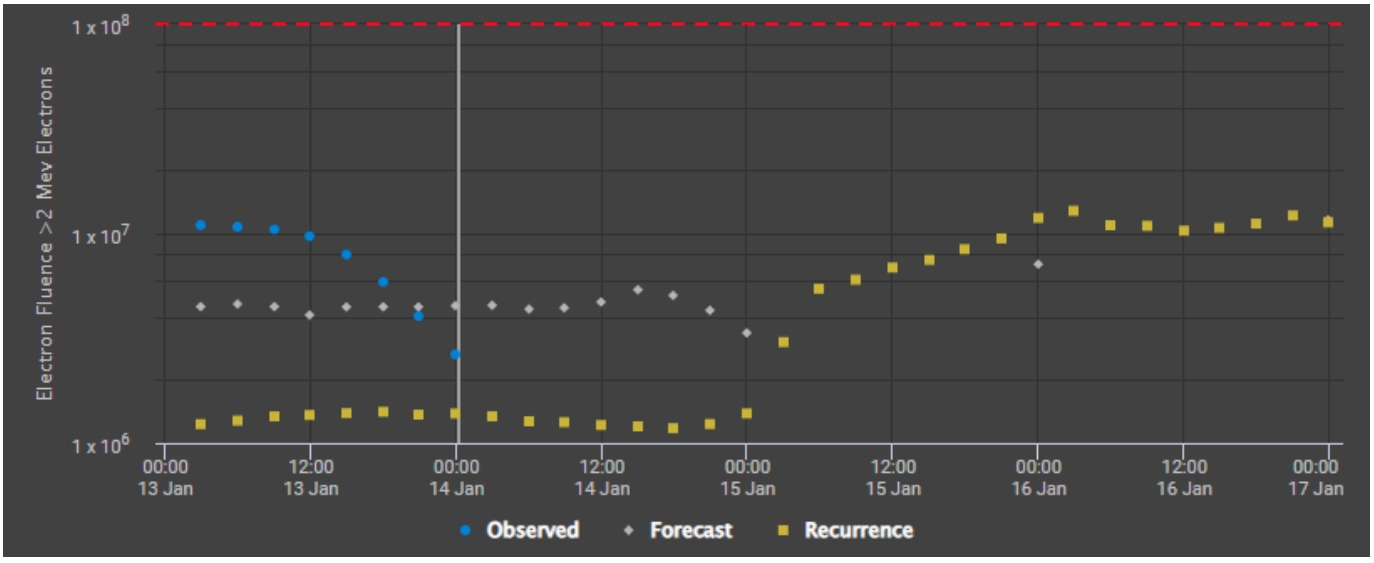
High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 has been at normal to moderate levels during the past 24 hours. The ongoing arrival of the HSS from CH08/- is expected to suppress the electron belts away from GEO. Flux levels potentially returning to moderate to high levels for a time before any connection to CH09/- from later on day 3 (16 Jan) is then likely to suppress electron belts once more.

Electron fluence is expected to remain below the active threshold, with REFM currently serving as a reasonable guide.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 3: MOSWOC REFM



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